George Washington Bridge Bus-Carpool Lane: 1-Year Operational Report

JOHN C. POWERS

A reserved lane has operated on the New Jersey approaches to the George Washington Bridge providing a time savings for buses and carpools in the peak a.m. commuter hours since October 1986. In addition to Interstate 95, the bridge provides access to Manhattan for much of northeastern New Jersey for six other major routes all of which converge within a mile of the bridge. This report reviews operational data for the first 12 months of the operation. Included are carpool, bus, and violator trends and enforcement activities. Also presented are long-term trends, a review of the potential for further preferential treatments, and some observations pertinent to measuring operational "success." The following conclusions have been reached. The reserved lane has achieved its operating goals. The presence of the bus-carpool lane has had a favorable effect on carpool formation. Continued daily presence of Port Authority of New York and New Jersey (PANYNJ) police should be adequate for effective enforcement. The eligibility of motorcycles for reserved lane use is not well understood. Added promotional efforts by the PANYNJ are in order. Operational data contained in this report should be used to review the possibility of opening a local-access toll booth for carpools only.

A feasibility study was undertaken in 1975 to identify opportunities in the I-80/95 corridor for instituting bus-carpool lanes (BCPLs). The study had the objective of identifying locations for lanes that had the capability of "increasing the person-moving capacity of existing highways" (*1*).

Reserving lanes on I-80 and 95 was a major focus of the study. Although this was found to be not feasible, the study recognized that improving the "bus only" reserved lane at the George Washington Bridge (GWB) was appropriate. A time savings of up to 10 min for buses and carpools (vehicles with three or more persons) was identified. In addition, this lane could operate without affecting nonusers because the reserved lane would use the shoulder where the road is narrowest. Design of the project was initiated in 1979, and construction began in 1985.

The GWB serves as a major link between northeastern New Jersey and Manhattan. In addition to local street access, five separate roadways come together on the bridge's New Jersey approaches. As shown in Figure 1, these roads provide access for a considerable number of vehicles traveling on I-80 and 95; US-1, 9, and 46; US-9W; NJ-4; and the Palisades Interstate Parkway (PIP).

Bureau of Transportation Systems Research, Division of Research and Demonstrations, New Jersey Department of Transportation, 1035 Parkway Avenue, Trenton, N.J. 08625.

Three separate toll plazas funnel traffic to the bridge's seven eastbound lanes, four of which are on the bridge's upper level and three of which are on the lower level. Westbound lanes are similar although no tolls are collected in keeping with the policy for all Hudson River crossings run by the Port Authority of New York and New Jersey (PANYNJ).

I-95 forms the central focus of the eastbound Bridge approaches and is the primary route for the reserved lane of Figure 2. Termed a bus-carpool lane to distinguish it from its predecessor, the reserved lane was inaugurated in October of 1986. Lane-use restrictions exist from 7 to 9 a.m. on weekdays to provide a path for buses and cars with three or more persons to bypass the congestion generated by the confluence of 23,000 peak-period commuters at the upper- and lower-toll plazas. This congestion typically extends to the intersection of NJ-4, a mile to the west. As constructed, the reserved lane allows users to save up to 8 min each.

Access to the lane is relatively simple because the lane has no entrances per se. Standard lane striping separates it from adjacent concurrent flow lanes. The reserved aspect of the lane is emphasized by standard high-occupancy-vehicle (HOV) lane diamond symbols (◇), which are repeated on all signing.

Cars and buses must have access to the I-95 express or local roadway at or before the NJ-4 ramps to take advantage of the reserved lane. As a result, carpools on US-1 and 9, as well as US-46, are unable to use the lane without a route change. Because the PIP accesses the upper level of the bridge at a point downstream of the I-95 toll plaza, PIP carpools are also unable to use the reserved lane without a route change. Signs are standard as shown by Figure 3.

OPERATIONAL HOURS

Data were collected throughout the a.m. peak period on a regular basis during the first year of operation. Observers sampled car occupants, vehicle use of the reserved lane, and total car and bus volume at the three toll plazas. Supplementary counts were made on several occasions to determine motorcycle use of the lane and to identify the commuter bus portion of the total bus volumes. Data were collected in each month except February and August when the weather interfered.

Some 26,000 cars, 3,000 trucks, and 180 buses cross the bridge between the hours of 6:30 and 9:30 a.m. on a typical weekday morning. Figure 4 illustrates how volumes and delays

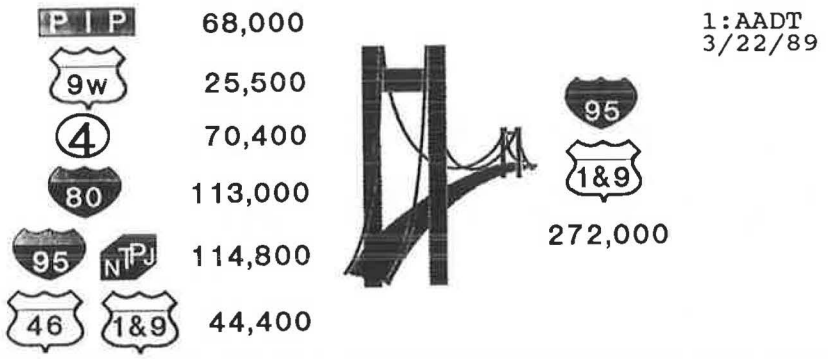

FIGURE 1 New Jersey approach roads' average annual daily traffic.

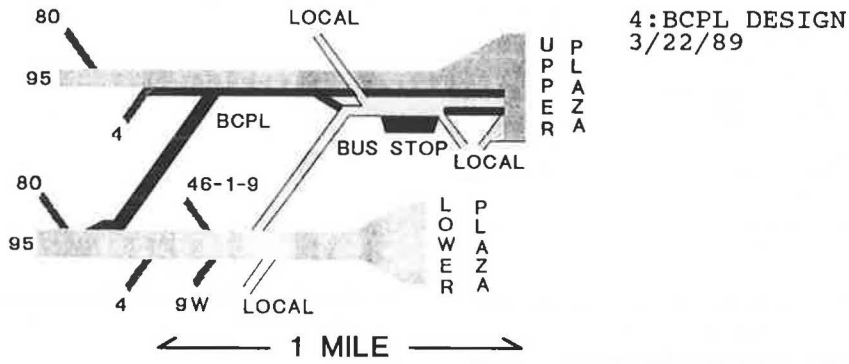

FIGURE 2 BCPL location.

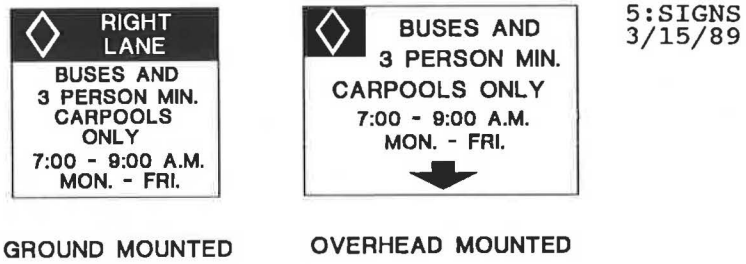

FIGURE 3 Typical signs.

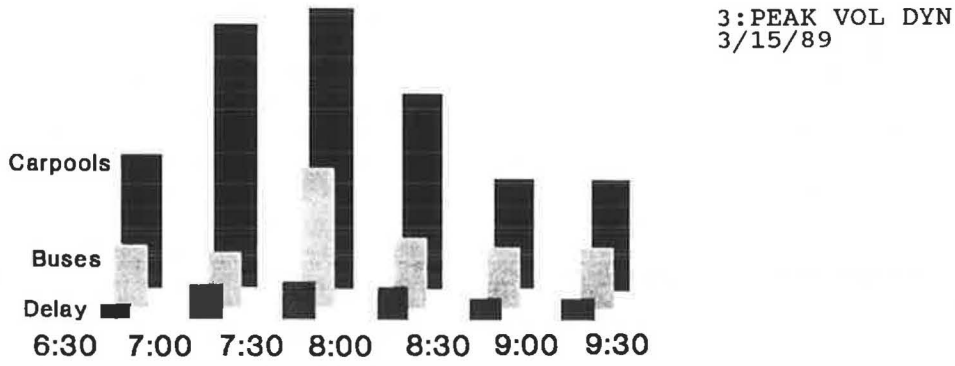

FIGURE 4 Peak-period characteristics.

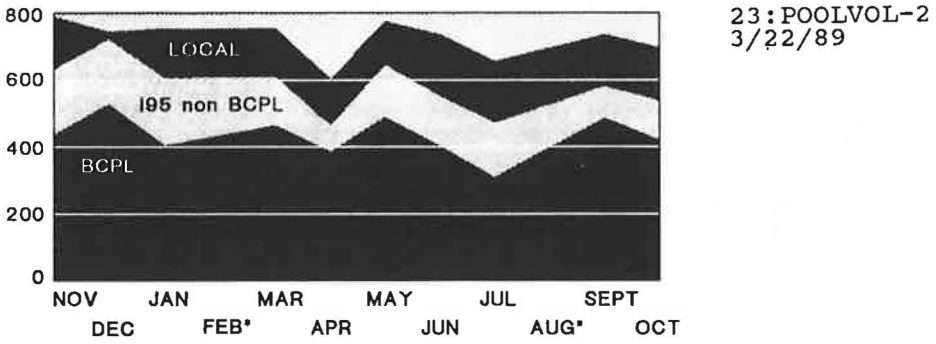

FIGURE 5 7 to 9 a.m. carpools.

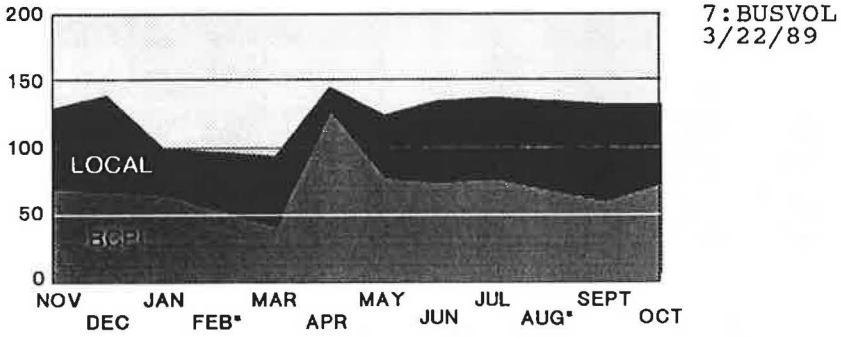

FIGURE 6 7 to 9 a.m. buses. (NOTE: Data not collected in February and August because of bad weather.)

vary within this time frame. The concurrent peaking nature of the carpools, buses, and delay (a function of all traffic) led to the choice of reserving the lane from 7 to 9 a.m.

FIRST YEAR SUMMARIES

Figure 5 illustrates how carpool volumes varied from month to month. On average, 730 carpools were present. About 580 used the I-95 approaches of which about 430 used the BCPL. Access via the local street system accounted for about 150 carpools.

Figure 6 illustrates in a similar fashion the bus data. An average of 70 I-95 buses used the BCPL. I-95 non-BCPL buses were virtually zero. The additional 50 buses arriving via the local street system bring the total to 120, on average.

The totals for all buses show considerable variability from month to month despite rather stable commuter bus schedules. For example, bus totals for all approaches combined were as low as 89 in March and as high as 140 in April. Calls to New Jersey Transit confirmed that few variations occur day to day in the operation of the commuter lines serving the bridge and the bus terminal in New York.

On-site counts revealed that only about 57 percent of buses observed using the lane were commuter buses, however, and the remainder of the buses serve a variety of purposes, such as school trips and charters. Noncommuter buses also show up on the PIP averaging 18 in June and July. Since no prequalification of drivers is required for BCPL use and the lane is quite accessible, all buses on I-95 tend to use the reserved lane. Commuter buses, the most stable portion of the daily peak period, average about 40 and the I-95 volume ranged from about 60 to more than 80.

BCPL Use

Use of the BCPL during a typical weekday is illustrated in Figure 7. Carpool presence is heaviest between 7 and 8 a.m. when about three-fourths of the 2-hr total arrive. Violators have distinctly different arrival habits being concentrated in the first and last 15 min of operation when they sense that police will be less likely to issue summonses. This effect is apparently typical of reserved lanes invoked for limited hours. During the core 1.5-hr period, violations occur at a rate of about 100 per hour and account for about 30 percent of lane use. In the other 30 min, the rate is about 360 per hour, a substantial amount since it is 20 percent of lane capacity. It is also about 70 percent of lane use. As a result, total violations average 330 and are more than 40 percent of lane use.

Despite a fully functional lane throughout the 7 to 9 a.m. peak period, the percent of the carpools that use the reserved lane is quite dynamic, as shown in Figure 8. Use typically approaches 80 percent of I-95 carpools at the main and lower plazas during the first ½ hr of the lane's operation and runs above the peak period average of 65 percent for the entire first hour.

Figure 8 also illustrates the range of delay commonly encountered during the peak period. The right vertical axis indicates the scale for minutes of delay, which equates to time

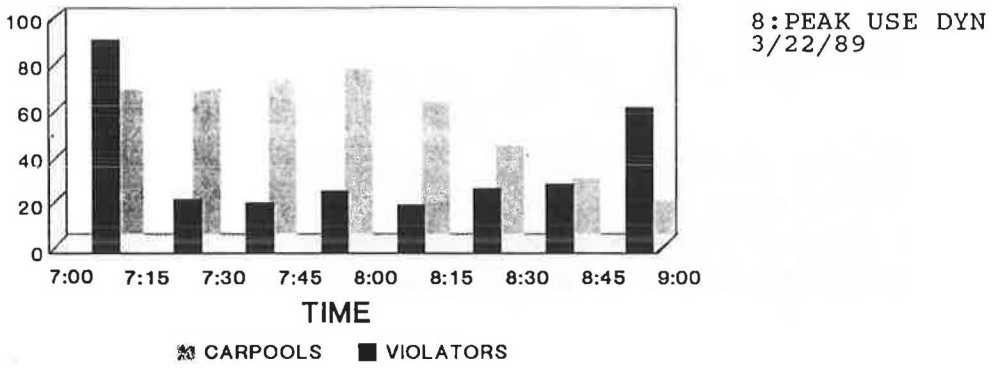

FIGURE 7 BCPL users.

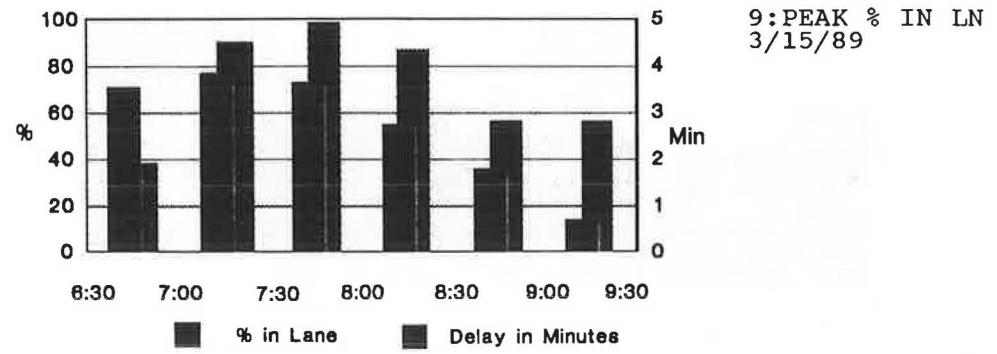

FIGURE 8 Use and delay.

savings available to reserved lane users. The range of delay is drawn from data taken during the 4 years preceding the lane's initiation and emphasizes the choice of 7 to 9 a.m. as a minimum operational period. As can be seen, carpool use of the reserved lane follows the variations in the delay. Although lane users decline after 8 a.m., the 8 to 9 a.m. totals remain substantial at a time when delays are still significant.

Despite the fair amount of carpools present before 7 a.m., congestion is not great. Also, carpool totals fall off greatly after 9 a.m. For these reasons, 7 to 9 a.m. is clearly a proper operational period. Although not shown, bus use is also greatest in the 7 to 9 a.m. period. Should congestion increase before 7 a.m., some reconsideration could be given to opening the lane earlier.

Enforcement

The rates of violation, previously presented on Figure 7, have been roughly stable at about 30 percent throughout the first year during the core 1.5 hr. Despite occupying as much as 20 percent of lane capacity, violators have not interfered with the viability of the lane because the peak rate of lane users (400 to 500 vehicles per hour) is well below the capacity of the lane.

Whether continued disregard for lane rules will escalate violations to the point where they inhibit operations is a concern. Because large increases in carpool use of the lane are not expected, maintaining violations at or near the current levels should be adequate to ensure continued proper operation of the lane.

Summonses by the Port Authority police on selected days during the first year, summarized in Figure 9, were reviewed to get an idea of what level of continued enforcement may be appropriate. As is often the case, heavier summonses in the early months of the lane's operation have been followed by gradual reductions, despite virtually daily presence of personnel throughout the first year. The implication from the experience with enforcement during the first year is that violations are manageable in the 100-to-200-per-day range, and continuing regular presence of enforcement personnel will be more important than the actual level of summons activity.

Peak-Period Summaries

Table 1 shows a summary of the first year data. To support long-term trend analysis, 4 months of the year have been chosen to represent the "summer" season and 4 additional months represent "winter." November through February are termed "winter" because they were found to best represent the lowest carpooling months, and April through July are termed "summer" because they best represent the highest carpooling months. Data taken on freeways in other states show similar trends.

The total number of carpools on all approaches now varies from 1,000 to about 1,100, including the 300 or so carpools using the PIP. Table 1 also shows the BCPL percentage of I-95, an important factor in our evaluation of the BCPL operation. Selection of this and other measures of effectiveness is described in more detail in the next section.

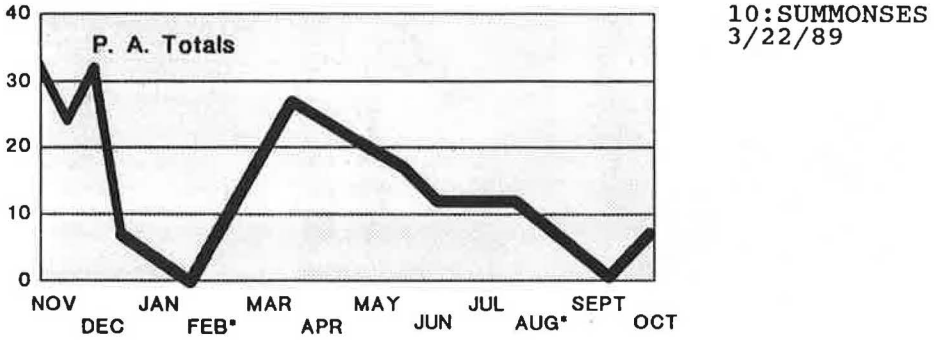

FIGURE 9 Summonses by Port Authority police. (NOTE: Data not collected in February and August because of bad weather.)

TABLE 1 7:00 TO 9:00 A.M. PEAK-PERIOD AVERAGE VOLUMES

	11/86 to 1/87[a]		4/87 to 7/87	
Location	Carpools	Buses	Carpools	Buses
Bridge Totals				
PIP plaza	337	2	320	14
I-95 plaza	765	120	745	132
Total	1,102	122	1,065	146
I-95 Plazas				
Upper via I-95	424	67	363	87
Upper via local	111	53	214	44
Lower	230	1	168	1
BCPL percentage of I-95 plazas				
Excluding local	65	99	68	99
Including local	59	56	57	66

[a]Although February is included in winter months, data were not available for this study.

MEASURES OF EFFECTIVENESS

In order to measure the effectiveness of the BCPL, the data were analyzed for several aspects of BCPL use.

Capture

Figures 10 and 11 illustrate how well the BCPL was able to "capture" its intended users. Buses and carpools at the main plazas fall into three groups: those on I-95 in the BCPL, those on I-95 out of the BCPL, and those arriving via the local streets.

Figure 10 shows how the carpools fall into each of the three groups in each month observed. On average, about 35 percent of the carpools did not use the BCPL. This group was fairly stable. The fluctuation in December is interesting as many local carpools appeared to have experimented with route diversions to gain access to the BCPL. Preopening analyses suggesting that the time savings would not support such diversions and the return to November-like splits are considered to confirm this effect. Preopening estimates also placed the I-95 nonuser portion at about 15 percent, close to the amount observed in most months. The substantial amount of pools that cannot use the lane (including PIP pools, which formed the control group) has been cause for a review of other opportunities to provide preferential pool treatment. The results of this review are discussed in following paragraphs.

Figure 11 similarly shows the percentage of buses. The portion of I-95 buses that did not use the BCPL is virtually zero. The volatility of bus trends, previously discussed in detail, is visible here as well. Unlike carpools, provision has been made for buses arriving via the local streets to access a preferential booth. Because of this advantage, further bus preferential opportunities appear unnecessary.

People Versus Vehicles

Figure 12 recaps how carpool and bus preferential treatments (including the BCPL and the preferential toll booths) pay off in terms of passenger use instead of vehicle use. The fact that 32.5 percent (some 7,500 people) receive a time savings although occupying only 4.5 percent of the vehicles (550) is primarily a function of the number of buses present. However, the carpool contribution is significant and represents an important reinforcement for existing carpooling behavior. At the same time, there is virtually no negative impact on nonusers because the lane operates primarily on the shoulder and the PANYNJ manages flows to the booths so that they do not go unused if there is a gap in BCPL arrivals.

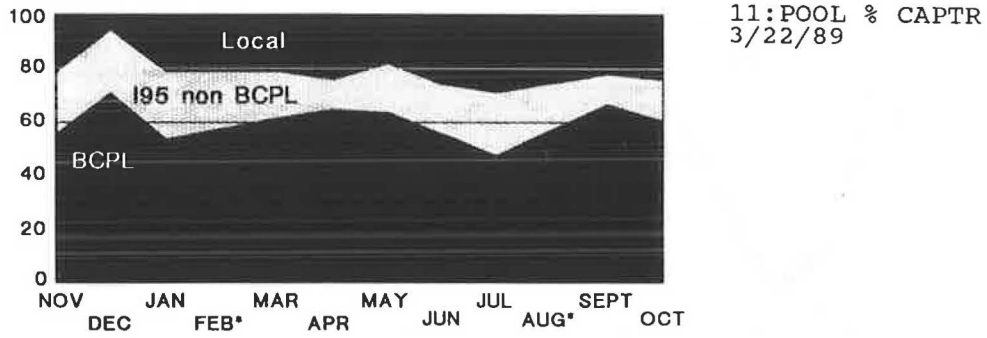

FIGURE 10 Carpool capture. (NOTE: Data not collected in February and August because of bad weather.)

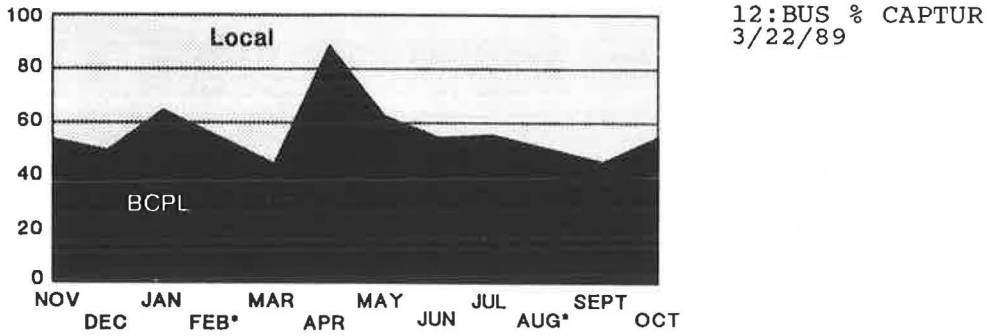

FIGURE 11 Bus capture. (NOTE: Data not collected in February and August because of bad weather.)

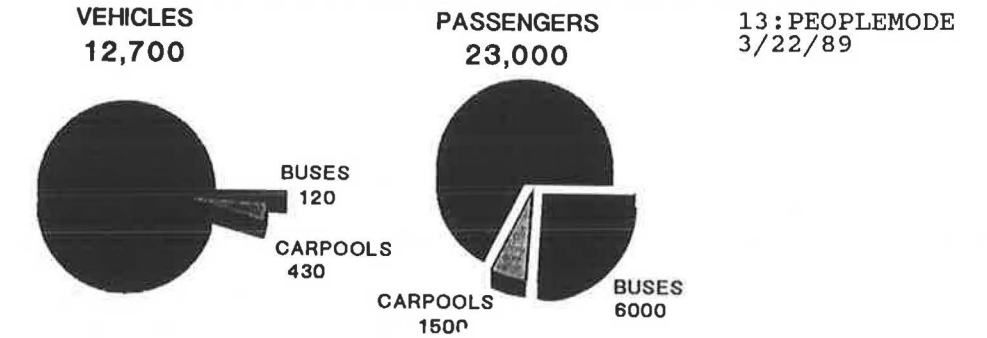

FIGURE 12 Preferential treatment payoffs in terms of passenger use versus vehicle use.

Trends Analysis

A trend analysis was performed to better understand the results and to form an opinion as to the success of the BCPL. Previous experiences, both in New Jersey and elsewhere, aided the design of the data collection and this analysis. The percentage of cars that are carpools, referred to as the "% 3+," is the primary tool for this analysis.

Banfield

Figure 13 illustrates data for the BCPL instituted on I-80 in Banfield, Oregon (*2*). Like the GWB, the minimum occupancy requirement of this reserved lane is three or more people per vehicle. It is of particular interest because data were collected throughout the first year as well as a full subsequent year. A comparison of the 2 years shows the danger of limiting analysis to the first year of operation. The follow-up data, taken 3 years later, not only give an entirely different perspective on carpooling trends, they also suggest that carpooling is subject to seasonal variation.

Garden State Parkway

Figure 14 illustrates the use of control-site observations to filter background trends such as seasonality. The information

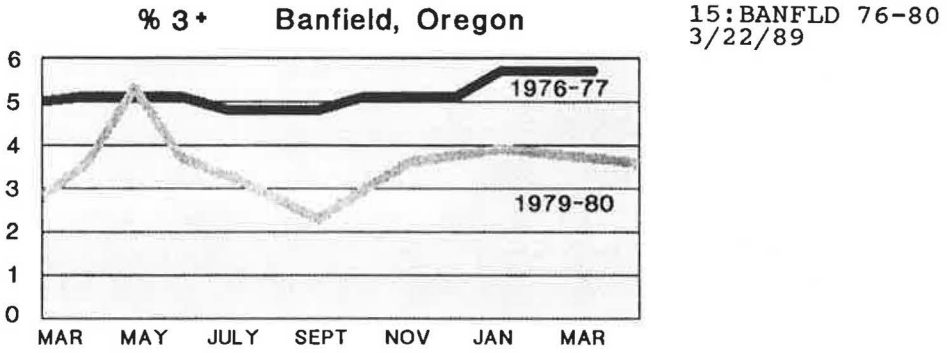

FIGURE 13 Percent 3+, Banfield, Oregon.

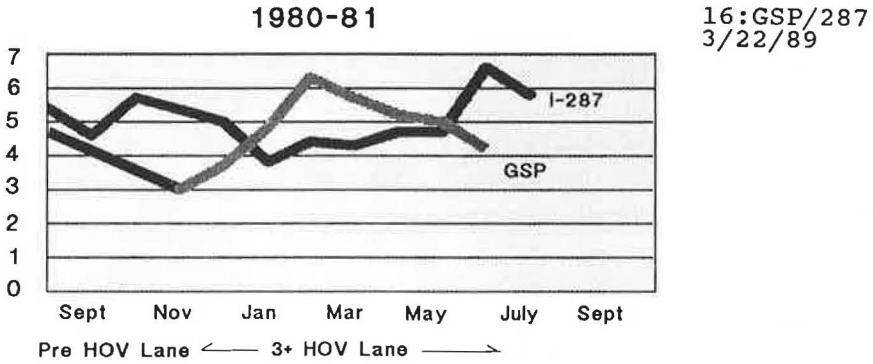

FIGURE 14 Percent 3+, Garden State Parkway.

is taken from the analysis of the now defunct Garden State Parkway (GSP) HOV lane, reported previously in *Transportation Research Record 906* (*3*). For that analysis, data were collected simultaneously at a nearby but independent section of I-287 before as well as during the HOV lane's operation. In this way, increases during the first 3 months, typical of new HOV lanes, could be clearly attributed to the HOV lane's presence. Similarly well accentuated is the dramatic dropoff that occurred in the next 3 months.

The conclusion that, in the short term, the lane was not functioning as well as desired could have been reached without the concurrent monitoring of I-287. However, the availability of the control-site data left no room for doubt. Certainly such confidence in the analysis should be present when making major decisions such as reducing the minimum eligibility requirement as was done in the case of the GSP. Note again that the I-287 data, free from the influence of the HOV lane, suggest that a seasonal trend exists.

GWB Data Collection

Figure 15 illustrates the application of multiple years of data collection and concurrent control-site monitoring to the GWB BCPL site review. The availability of 3½ years of "before" data, a direct result of long delays encountered during the design and construction of the lane, illustrates the value of monitoring the site on a continuing basis. Without such data to explain the substantial drop in carpooling, explaining the opening day volumes would have been impossible.

Data for 1983 and part of 1984 were analyzed for seasonal influences and remaining data collection was reduced to sampling 8 of the 12 months. In this way, costs were reduced by one-third without compromising the quality of the data.

BCPL Impacts on Carpooling

In addition to the distinct seasonal nature of carpooling, the long-term negative trend of carpools is clearly evident. Knowledge of this trend is important to understanding the true value of the BCPL because dramatic increases in carpooling have not occurred during 1987, the first year of operation. Instead of concluding the BCPL a failure, the evaluation is based on how well the lane supports existing carpooling behavior and reinforces the time savings previously available only to buses—the objectives set prior to the opening of the BCPL.

Discussion and Supplemental Analyses

Caution must be advised against overuse of such data. For example, the data might appear to support the theory that the BCPL has changed carpooling trends at the I-95 plazas. Such a conclusion could be based on the increase in carpooling (0.5 percent) evident between June 1986 and June 1987, an amount greater than any seasonal or year-to-year change since 1984. At the same time, carpooling on the PIP has continued to show a negative year-to-year trend and has actually become lower in percentage than at the I-95 plazas. Proper statistical

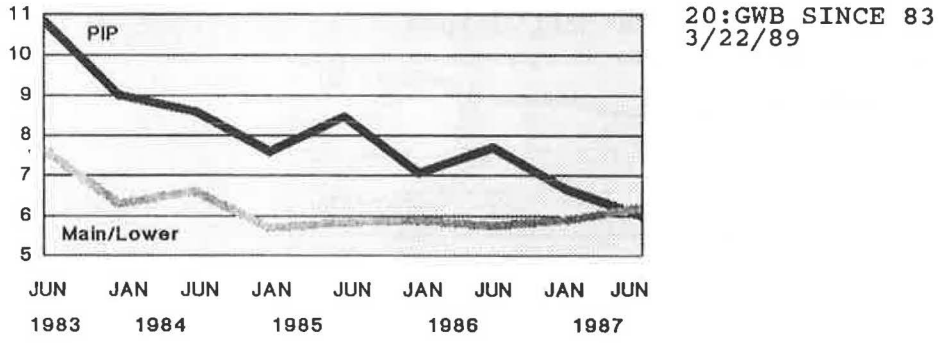

FIGURE 15 Percent 3+, GWB seasonally.

analysis is impossible with only two data points for "after" data, thus such interpretation of the data is interesting to note only as a possibility and as a focus for further data collection efforts, although none are currently planned.

In forming an opinion as to the success of any BCPL, immediate increases in carpooling are certainly impressive. The GWB BCPL data demonstrate that an operation may provide important benefits despite less dramatic performance. In fact, it is probably unrealistic to expect that a BCPL will, by itself, be responsible for major changes in carpooling behavior. Thus, to set major increases in carpooling as the goal without careful consideration of the entire ridesharing program and the current trends is more likely to be a formula for measuring failure, rather than success.

Toll Rate Changes

On April 12, 1987, daily commuter toll rates increased from $1 to $2 and noncommuter rates increased from $2 to $3, whereas carpool rates remained at $0.50 a trip. Thus the apparent trend toward increased carpooling might be attributed to this new rate structure. However, effects of an increase in toll fees on carpooling, if present, should be observable at all plazas because the discount was not conditioned on presence in the BCPL. In fact, rather than increasing, the trend at the PIP is quite the opposite, as previously discussed.

This result should not be surprising because most of the automobiles present during the peak hours carry daily commuters to whom toll fee increases of $1/day ($250/year) can be considered minor in light of substantial employer subsidies. In summary, the toll increases that took effect on April 12, 1987, do not appear to have affected carpooling rates at the GWB.

Motorcycles

In order to decide how well motorcyclists understand their eligibility for lane use, several motorcycle-specific counts were made. These counts identified that only one motorcycle was a regular user of the lane, although as many as 42 were present between 7 and 9 a.m. Clearly then, motorcyclists are not generally aware of their ability to use the BCPL. Although it is not obvious that they would in fact use it, a contact with a motorcycle organization confirmed that motorcyclists are not generally aware that the rules permit motorcycle use. This is understandable because the word "motorcycles" is too long to be accommodated on any of the signs. Thus, distributing more explanatory information has been recommended.

PIP

The dramatic and apparently continued dropping of the number of carpools on the PIP seen in Figure 15 is disturbing. In particular, the summer 1987 dropoff to less than 6 percent carpools is unprecedented in that it fell below the average at the I-95 plazas. A similarly large nonseasonal drop in PIP carpooling was previously observed in the summer 1984 data.

Attempting to reverse this trend by providing preferential treatment for carpools on the two lane approaches to the PIP plaza is not feasible because of physical constraints. The only apparent alternative, a preferential toll plaza at a local street access point, was ruled out several years ago by a study sponsored by the PANYNJ (*4*). The booth then studied is currently used only for oversize load permit operations. Because much of the data on carpools for that previous PANYNJ study can now be updated, revisiting the study has been recommended.

An additional benefit of such a booth operation would be that all carpools now accessing the main plaza via the local streets could potentially reroute. Certainly, any resulting impacts on traffic patterns on the local street system would need to be ameliorated. As previously discussed, local buses, which do not use the BCPL, would not need this booth because PANYNJ police give all buses priority at one toll booth. Similar treatment of local-access carpools at the toll plaza is not feasible, however. Thus exists the need for a separate local-access carpool booth.

As mentioned previously, sampling techniques have been used to reduce data collection costs. Data were collected for a full year with data collected in each month to establish seasonality. A sampling method was also used during each peak period. Figure 16 illustrates how the % 3+ varies during a typical peak period.

Experience on previous efforts led to the choice of 15 min as the basic analysis period and data were taken in 10 of every 15 min throughout the peak (*5*). As can be seen, data were collected from 6:30 until 10 a.m. despite the choice of 7 to 9 a.m. as the BCPL operational period.

Summaries of data were simultaneously assembled for 6:30 to 9:30 a.m. (although not presented here) to aid in the anal-

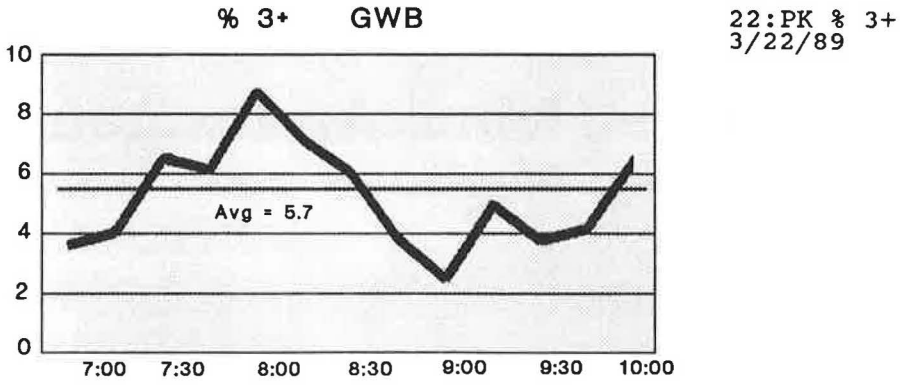

FIGURE 16 Percent 3+, GWB peak period.

ysis in the event of time shifts of delay or carpooling behavior. These shifts did not occur. Data were also collected and summarized through 10 a.m., for separate comparisons to toll-collection data (again not presented here). The highly dynamic carpooling rates in the peak period suggest that selective sampling in only a portion of the peak can lead to erroneous estimates of average behavior, especially in the event of time shifting. Thus exists the benefit of extended data collection periods. Ironically, comparing the summaries for the three basic analysis periods (7 to 9, 6:30 to 10, and 7 to 10 a.m.) led to an average of about 5.7 percent carpools in each case because of the specific nature of the trends at this location.

ACKNOWLEDGMENTS

The contributors to this project were many and varied. Essential in a 13-year process from conception to full operation is unwavering support from management and coworkers; this project was certainly blessed in that regard. But for the understanding, cooperation, and belief in eventual success by the New Jersey Department of Transportation's Design and Traffic Engineering staff, the complexity of this effort would have been its downfall. FHWA funding and participation by New Jersey State Police and numerous people within the Port Authority of New York and New Jersey were also important to the planning and operation of the reserved lane. Neither the need for nor the success of the operation could be understood, however, without the dedicated support of those who put up with the long and often difficult hours and work conditions involved in providing vehicle occupancy data. Last but not least are those who assisted in the preparation of this report.

REFERENCES

1. C. O. Pratt and H. S. Levinson. *Route 80/95 Bus-Carpool Lane Feasibility Study*. Project Report 78-002-7616. Wilbur Smith and Associates; Bureau of Operations Research, New Jersey Department of Transportation, Trenton, 1978.
2. *Banfield Freeway High Occupancy Lane Traffic Study*. Metropolitan Section, Oregon Department of Transportation, Salem, 1982.
3. J. C. Powers. Garden State Parkway HOV Lane. In *Transportation Research Record 906*, TRB, National Research Council, Washington, D.C., 1983, pp. 54–56.
4. M. C. Gersten. *George Washington Bridge, Borough of Fort Lee Traffic Study*. URS Company, Inc.; Port Authority of New York and New Jersey, New York, June 1985.
5. J. Powers. *An Analysis of Peak Period Auto Occupancy—An Interim Report for the George Washington Bridge Bus-Carpool Lane*. New Jersey Department of Transportation, Trenton, Aug. 1985.

Publication of this paper sponsored by Committee on Ridesharing.